EUROPEAN CENTRAL BANK
EUROSYSTEM

Climate risk scenarios for economic and financial stability analysis

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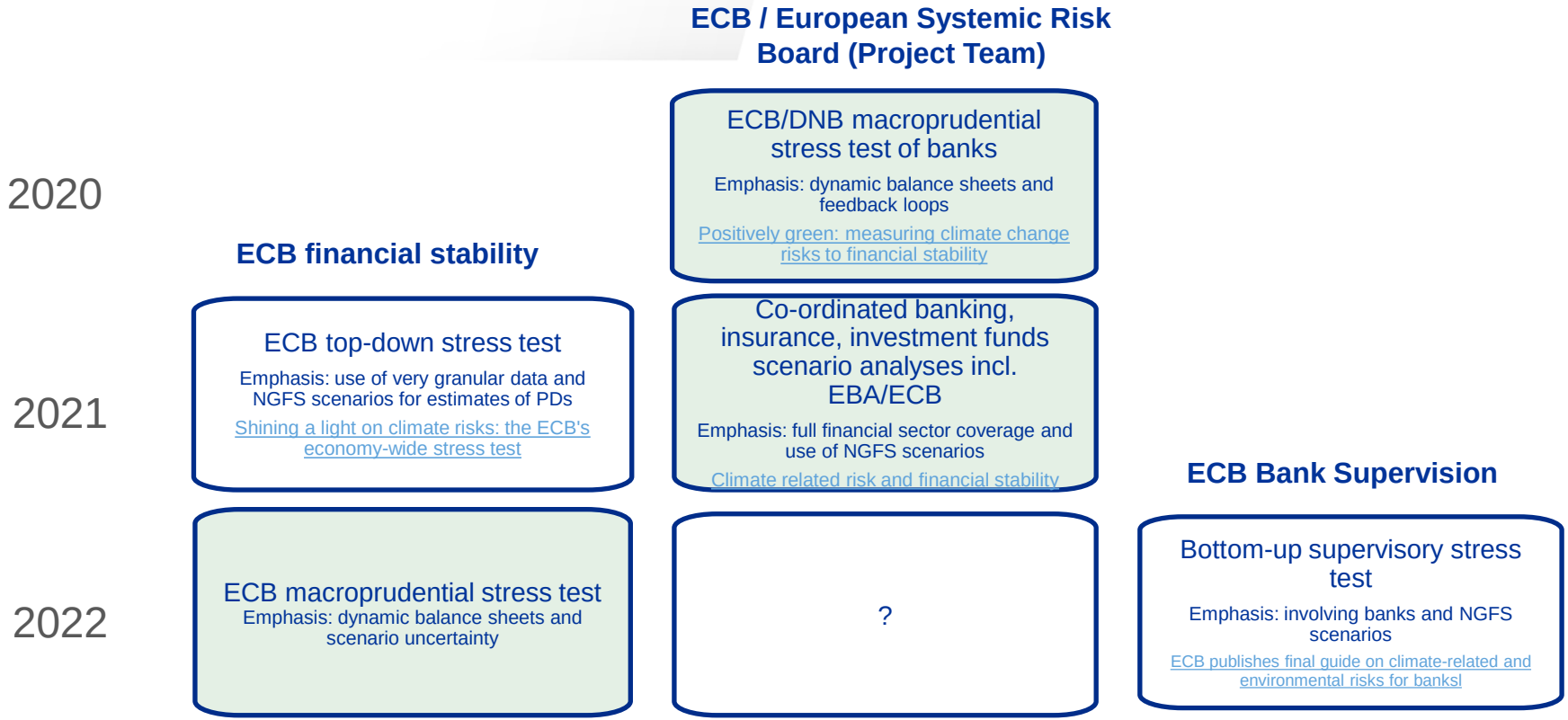
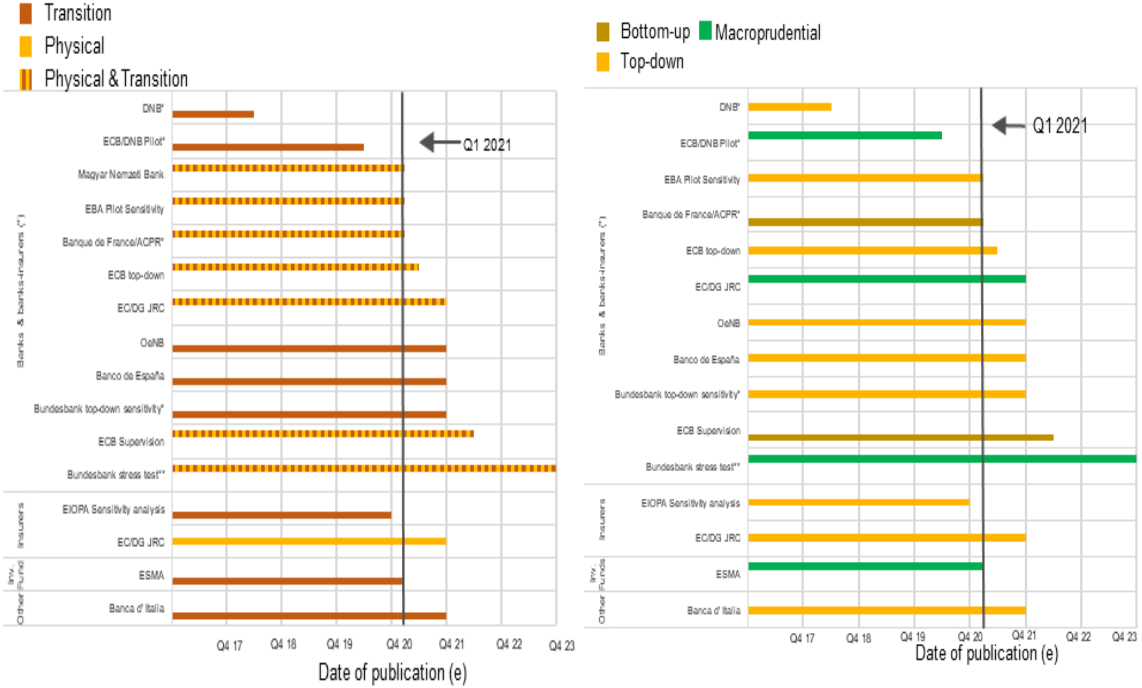
European climate stress test initiatives: *Cheat sheet*



Overview: *Convergence of approaches*

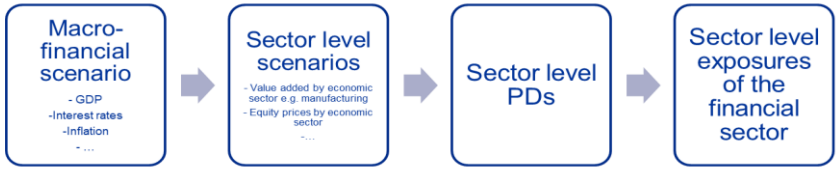


Source: Climate-related risk and financial stability, 2021

- Increasing interest in modelling both physical and transition risks
- Convergence of horizon and scenario choices (NGFS)
- Predominance of top-down exercises and growing interest in macroprudential aspects
- Increasing use of granular information (moving from sector-level to firm-level data and models)

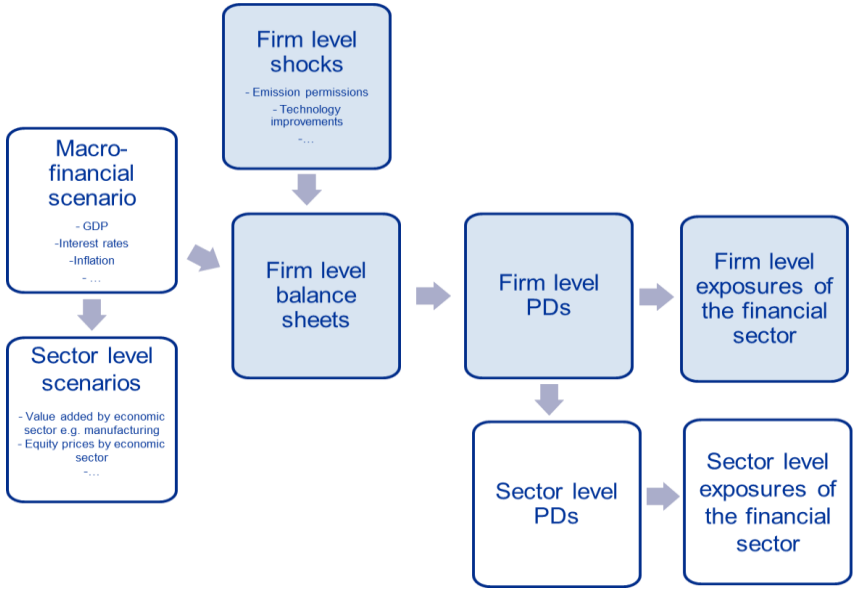
Evolving stress test methodologies: *Toward more granular datasets*

Sector-level approach for credit risk



Source: Climate-related risk and financial stability, 2021

Firm-level approach for credit risk

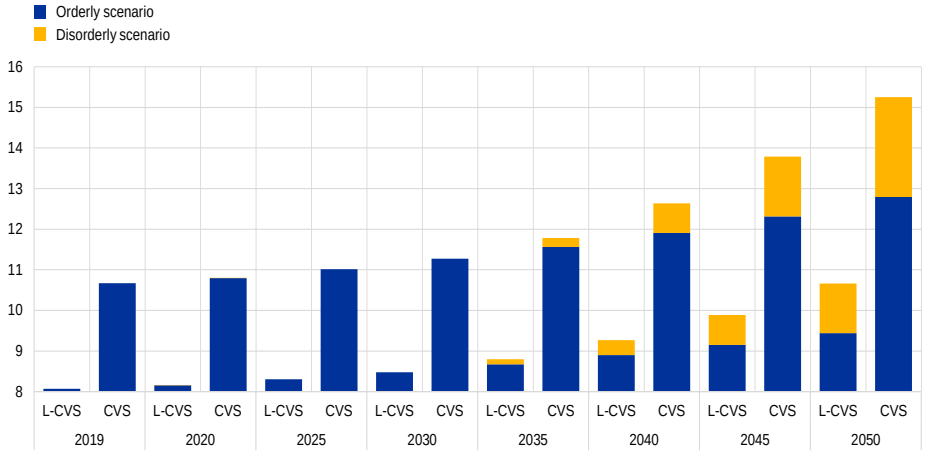


- Move toward firm- and security-level models to fully explore the distribution of climate-related risks in the corporate sector

Use of granular bank-sector exposures: *Probability of Default*

- Use of **time-series** information for **banks' exposures** split in line with a **4-digit NACE** in 2013Q3 - 2019Q4
- Estimating probability of defaults as dependent on macro-financial variables and environmental performance indicators related to carbon and coal prices
- Carbon and coal prices significantly impact the performance of loans to climate sensitive sectors

Impact of NGFS scenarios on banks' NPL ratios for climate vulnerable sectors (CVS) and less climate vulnerable sectors (L CVS)

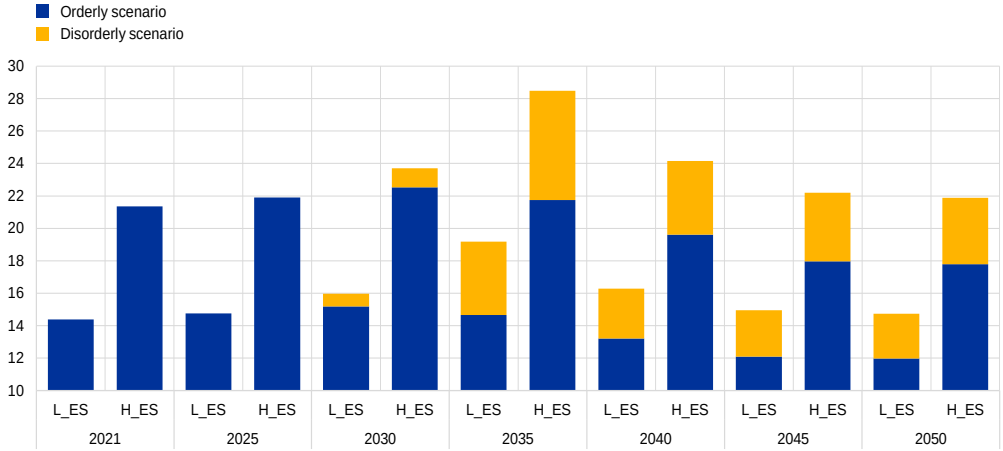


Source: Climate-related risk and financial stability, 2021

Use of loan level information: *Anacredit and Loss Given Default*

- Use of **Anacredit to measure and model LGDs** on unsecured exposures
- Regression of LGDs on country level macro-financial variables and energy prices
- LGDs generally increase with an increase in the energy prices, and this effect is stronger for the sectors with high use of energy

Impact of change in energy price on LGDs under the orderly and disorderly NGFS scenarios for low-energy and high-energy sectors



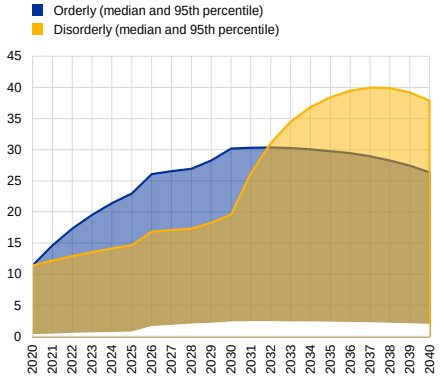
Source: Climate-related risk and financial stability, 2021

Use of firm-level data: *Profitability effect of carbon prices*

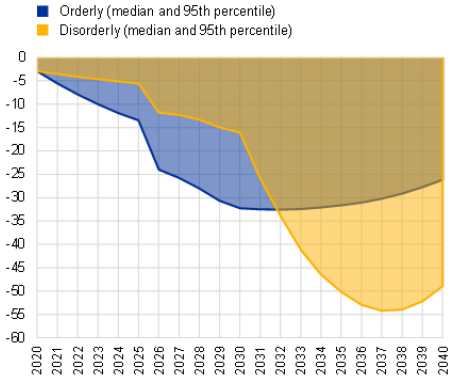
- Use of **firm-level balance sheet indicators** and reported emissions and allocated free allowances in the EU ETS
- Projecting firms' costs and profitability under the assumption that firms reduce their emissions in proportion to changes in aggregate emission pathways

Firms' expenses on emissions allowances (left panel) and firms' profitability (right panel) under NGFS carbon price scenarios

(expenses on emissions allowances; percentage of total costs)



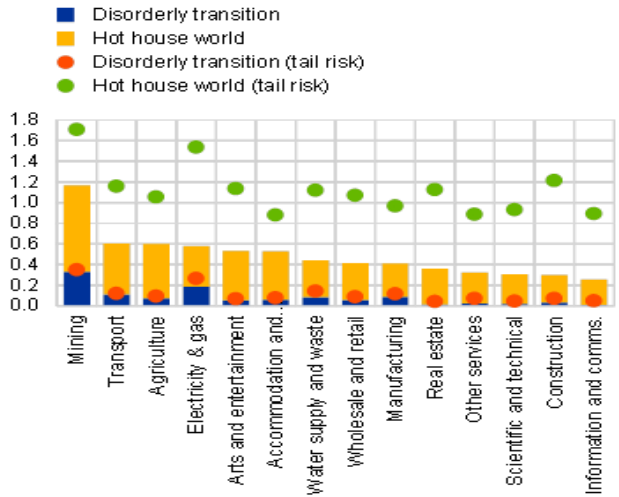
(changes in profitability; return on sales)



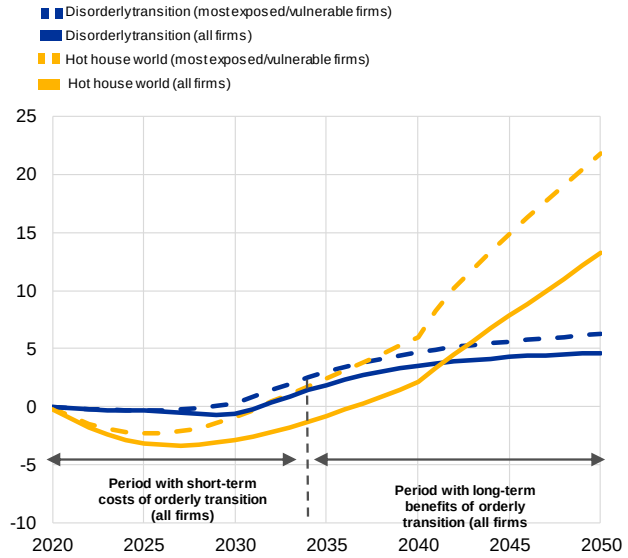
Source: Climate-related risk and financial stability, 2021

Use of firm-level data: *ECB top-down stress test*

Probability of firm defaults by sector



Probability of firm defaults over time in NGFS scenarios



Sources: NGFS scenarios, Four Twenty Seven, Urgentem, Bureau van Dijk – Orbis database, Bloomberg Finance L.P., Refinitiv, AnaCredit and ECB calculations. See also: Alogoskoufis et al. "Climate related risks to financial stability", Financial Stability Review, May 2021.

Notes: Left panel: Differences in firms' default probabilities by sector and group of firms (mean firms, and firms mostly exposed to physical risk). The bars represent the median changes in default probabilities over the next 30 years; the dots report the changes in default probabilities when considering the firms that are most exposed to physical risk (95th percentile based on firms' physical risk score). Right panel: solid line is median across all firms in the sample, dashed line is the average of most exposed/vulnerable firms in the sample.

Forward looking scenario analyses: *System-wide application of NGFS scenarios*

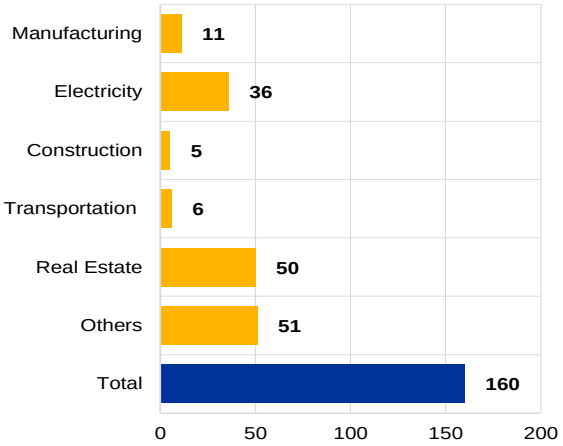
	Banking sector	Insurance sector	Investment funds
NGFS Scenarios	**Disorderly** and Hot house	**Disorderly** vs. Orderly (baseline)	**Disorderly** vs. Orderly (baseline)
Horizon	**30 years**	**15 years** (data as of 2035)	**15 years** (data as of 2035)
Sample	26 volunteer EU banks participating in the EBA pilot exercise	1569 EEA (excl. UK) domiciled insurance companies on a solo basis	23,332 (therein 18,513 UCITS, 1,555 AIFs and others not classified) (EUR 8 trillion investment holdings)
Financial exposures	Non-SME exposures to non-financial obligors domiciled in EU countries	Equity, corporate debt (excl. covered bonds) to climate-sensitive sectors (power, fossil fuels, transport, manufacturing) and government bonds	Equity, corporate debt exposures to 21,107 unique non-financial corporations.
Transmission channels	**Credit risk** (Probability of Default and Loss Given Default)	**Asset price revaluation**	**Asset price revaluation**
Relevant information	Data collected in the EBA pilot exercise as of end of 2019 (at the level of obligor). PDs from ECB's top-down (2021) stress test exercise	Regulatory reporting under Solvency II. Detailed production level data from 2° Investing Initiative	Morningstar, Refinitiv, ESMA

Source: Climate-related risk and financial stability, 2021

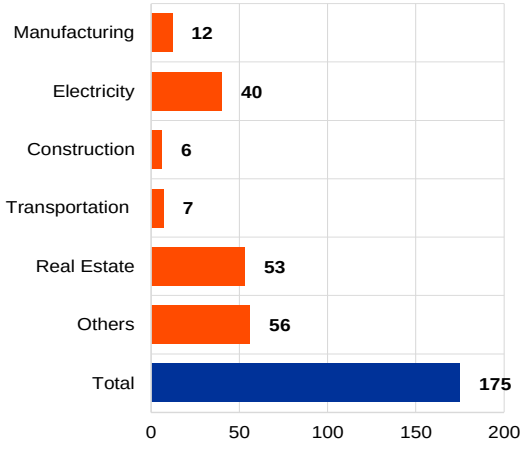
Climate scenario analysis: *Banking sector*

Bank credit losses including contributions to the overall impact by sector

under the disorderly scenario



under hot house world scenario



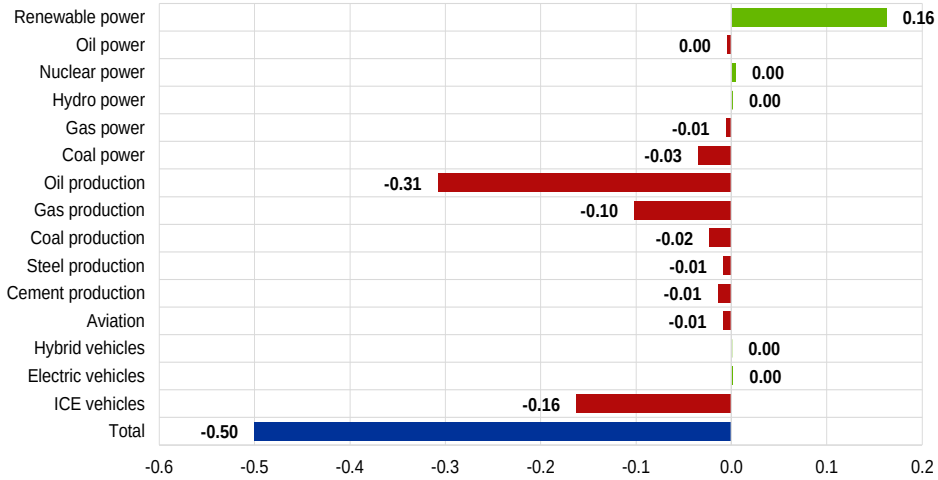
Source: Climate-related risk and financial stability, 2021

- Disorderly transition and no policy adjustment lead to higher loan defaults and asset valuation losses for the European financial sector
- Concentration of climate risks in selected portfolios e.g. banks' loan exposures to electricity and real estate, insurers' holdings of equity related to production of oil, gas and vehicles, investment funds' holdings of assets related to energy sectors and basic materials

Climate scenario analysis beyond banking: *Insurance and investment funds*

Insurer losses on equity and corporate bonds incl. contributions to the overall impact by sector under the disorderly scenario

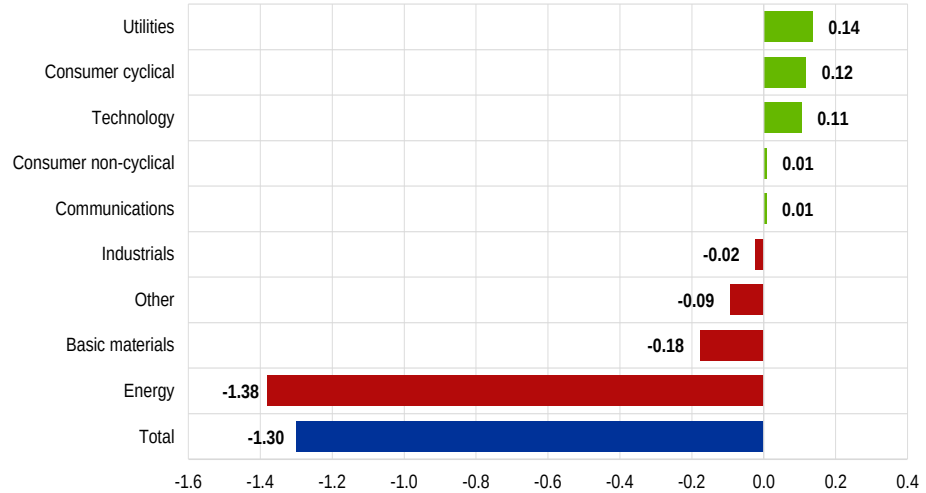
(percentages)



Source: Solo insurance undertakings reporting under Solvency II for the fourth quarter of 2019.

Investment fund losses incl. contributions to the overall impact by sector under the disorderly scenario

(percentage of funds' assets)



Sources: ESRB (2020), Vermeulen et al. (2018), Morningstar, Refinitiv and ESMA.
Notes: Application of energy transition risk asset valuation scenarios to EU fund equity, corporate bond, and fund-to-fund holdings, based on the NGFS Phase 1 Disorderly scenario developed by NGFS 2020a and 2020b, and adapted to financial markets by (Allen et al. 2020 and Devulder and Lisack 2020. Each row shows the contribution of each GICS economic sector to system-wide losses, as a percentage of total system assets included in the scenario exercise (equitiesy, corporate bonds, and shares issued by other investment funds), for funds holding assets issued by firms in that GICS sector. Indirect holdings are also included, i.e. we record losses on fund investments are recorded in other funds that are exposed to markdowns in asset values. The UK United Kingdom and the Channel Islands are included in this sample.

New lessons

- **Long-term scenarios** are different: financial stability risks unfold only gradually and over an extended time frame, in contrast with the abrupt materialisation of risks ingrained in most stress-test scenarios

- The **constant balance sheet** perspective is not best suited to scenario analysis spanning over decades

- Need for increased **data quality and coverage**: e.g. for transition risks a broader coverage of verified firm-level GHG emissions, especially for smaller and non-listed firms; for physical risks data on the geographical location of firms' assets and mapping of physical risk indicators into data on historical damage realizations

- Work toward boarder **coverage of channels**: e.g. stress testing of liability side of balance sheets of insurers, fire-sales and interconnectedness

Annex

ATC/FSC Project team on climate risk monitoring 2.0: Focus

Common basis

- **Coverage**:
  Transition & physical risks
- **Scope**:
  Banks & non-bank financial intermediaries (insurance, investment funds & OFIs)
- **Data basis**:
  Pool of public/ confidential, official. commercial datasets

WS1
Risk identification & monitoring

- **Main focus**:
  Risk metrics and indicators, updatable dashboards, risk interaction
- **Data focus**:
  Exposure mapping (banks, insurers, investment funds), monitoring financial markets
- **Outputs**:
  Risk dashboard, sensitivity assessments (incl. tail risks)

WS2
Risk assessment & stress testing

- **Main focus**:
  Scenario-based forward-looking risk assessment, modelling of the transmission of risks (e.g. PD models)
- **Data focus**:
  Building on exposure mapping
- **Outputs**:
  Operational scenarios, scenario analyses, implementable models (and best practices)

“Handbook”

Detailing methodologies used in the pilot exercises

Comprehensive “library” of existing methodological solutions incl. brief description of data, uses, analytical assumptions, and references

Fostering exchange of methodologies and transparency